Exploration and LAT (Lunar Architecture Team) Update

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Outline

- **NASA's Mission and Vision**
- **U.S. Scientific Interests**
- **Global Exploration Strategy**
- **Lunar Architecture**

NASA's Vision and Mission

- **The Vision for Space Exploration:**
  - Fundamental goal "to advance U.S. scientific, security, and economic interests through a robust space exploration program"
    - NASA has embraced this challenge as the Agency's vision
    - SMD leadership role to advance U.S. space and Earth science interests in the context of the vision

- **NASA's Mission:**
  - To pioneer the future in space exploration, scientific discovery, and aeronautics research
    - SMD leadership role to pioneer the future in scientific discovery

U.S. Scientific Interests

Administration Priorities
NRC Scientific Context for Exploration of the Moon
NAC Science Workshop
Lunar Sortie Science Opportunities
SMD Role

FY 08 Administration R&D Budget Priorities

- **American Competitiveness Initiative**
  - Basic Research in the Physical Sciences and Engineering
- **Single Agency R&D**
  - NASA and the Vision for Space Exploration Cited as Example
- **Interagency R&D Priorities**
  - Homeland Security
  - Energy Security
  - Advanced Networking and High-End Computing
  - National Nanotechnology Initiative
  - Understanding Complex Biological Systems
  - Environment
    - U.S. Integrated Earth Observations System
    - U.S. Climate Change Science Program
    - U.S. Ocean Action Plan
    - U.S. and Global Supplies of Fresh Water

Prioritized Lunar Science Goals from NRC Interim Report: Early Phases of the Vision for Space Exploration

1. **Fundamental Solar System Science**
   - Characterize and date the impact flux (early and recent) of the inner solar system.
   - Determine the internal structure and composition of a differentiated planetary body.
   - Determine the compositional diversity (lateral and vertical) of the ancient crust formed by a differentiated planetary body.
   - Characterize the volatile compounds of polar regions on an airless body and determine their importance for the history of volatiles in the solar system.

2. **Planetary Processes**
   - Determine the time scales and compositional and physical diversity of volcanic processes.
   - Characterize the cratering process on a scale relevant to planets.
   - Constrain processes involved in regolith evolution and decipher ancient environments from regolith samples.
   - Understand processes involved with the atmosphere (exosphere) of airless bodies in the inner solar system.

3. **Other Opportunities (additional information is required for these)**
   - Utilize data from the Moon to characterize Earth's early history.
   - Determine the utility of the Moon for astrophysics observations.
   - Determine the utility of the Moon as a platform for observations of Earth.
   - Determine the utility of the Moon as a platform for observations of solar-terrestrial processes.

NAC-led Lunar Science Workshop

- **The NAC Chair has asked the Science Committee and Subcommittees to convene a workshop to identify lunar science priorities for use in influencing Lunar Exploration architecture and capabilities**
  - Led by NASA Advisory Council Chair
  - Planned for Early 2007
- **Historically comparable to 1965 Woods Hole conference for Apollo**
- **Overall objectives:**
  - Consider exploration science, Lunar science, and Lunar-based science for a return to the Moon
  - Develop science objectives and priorities as contribution to return to the Moon program
  - Planning, spacecraft design, training, and operations
  - Consider Decadal Surveys and other strategic inputs

Open ROSES Element: Concept Studies for Lunar Sortie Science Opportunities

- **NASA is soliciting proposals for concepts that could be carried out on future lunar sorties.**
- **Proposers should define Lunar Sortie Science Opportunity investigations that would have science return relevant to identified science priorities and could be carried and deployed as payloads of opportunity on sortie missions.**
- **There is currently no specific flight opportunity for these concepts; however, the selected concepts may help refine future mission operations and resource needs.**
- **When a flight opportunity is available, NASA intends to issue an Announcement of Opportunity with specific science and operational requirements.**
- **Key Information:**
  - Expected annual program budget for new awards: ~$750K
  - Number of new awards pending adequate proposals of merit: ~5-10
  - Maximum duration of awards: 1 year; 6-9 months preferred
  - Due date for proposals: October 27, 2006

Coordination between the Exploration and Science Mission Directorates

- **SMD serves a Program Science role for exploration programs and missions**

- **SMD will undertake appropriate lunar science activities enabled by exploration**
  - Science of the Moon (research with the Moon as the subject)
  - Science on the Moon (use of the Moon as a laboratory)
  - Science from the Moon (use of the Moon as a platform)
  - Science near the Moon (trans- and cis-lunar space environment)

- **ESMD will undertake the research and missions required to enable exploration**
  - Including human health and safety, e.g., ESMD RAD instrument on the SMD MSL
  - ESMD implementing LRO and the LPRP
    - SMD identified Program Scientist
  - SMD is also sponsoring precursor science

- **ESMD will develop exploration architectures**
  - SMD participates in ESMD-led strategy and architecture development to ensure compatibility and opportunity for science
    - Past examples include ESAS and LRAS
    - Current examples include the Synthesis Team and the Lunar Architecture Team

SMD Serves A Program Science Role for Exploration

- **Potential science opportunities enabled by human exploration activities must compete in the same prioritization process as the rest of the SMD science program, since the funds come from the same pool.**

- **Use established, community-based processes to establish science priorities**
  - NRC study on lunar science priorities
  - Workshops and Roadmaps
  - Competitive, peer reviewed science and mission opportunities

- **Sponsor precursor science (research, analysis, and missions):**
  - Planetary Science: Moon, Mars, and other destinations. Examples:
    - M3 on Chandrayaan-1 selected through the Discovery Program
    - Mars Exploration Program
  - Heliophysics: Space weather and space radiation. Examples:
    - ACE, SOHO: provide situational awareness
    - STEREO, Solar Dynamics Observer: provide next generation observations

- **Sponsor science that leverages Exploration opportunities**
  - Analysis of LRO data for scientific objectives
  - Open solicitation: Concept Studies for Lunar Sortie Science Opportunities

SMD Science Priority Strategy

- **Priorities set through Dialog with the Science Community**
- **Strategic recommendations on science priorities via the NRC**
  - Decadal surveys
  - Focused questions of a strategic nature
  - Review of strategic plans
- **Tactical advice on implementation of strategic priorities via**
  - Science committee of the NAC and subordinate groups
  - Workshops with science investigator community
  - Participation in major professional societies (AGU, AMS, AAS, etc)
- **Technical interchange on detailed requirements and engineering trades via funded Principal Investigators and Science Teams**

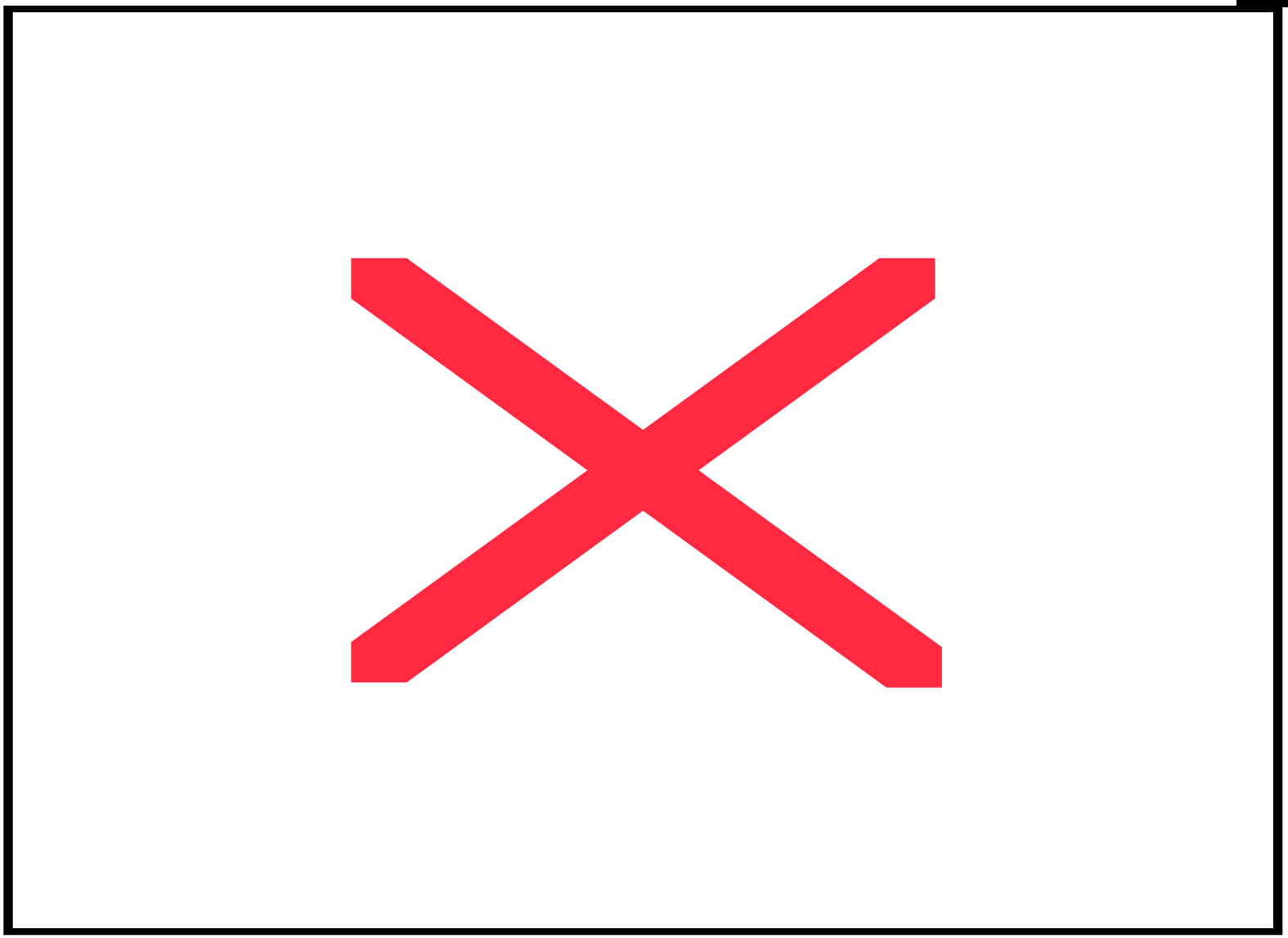
Global Exploration Strategy

Strategy and Architecture

Process

Themes and Objectives

NASA's Exploration Strategy



Strategy and Architecture

- **NASA initiated a process to:**
  - Generate a global set of lunar Themes and Objectives, and
  - Develop an architecture based upon select Objectives and within the cost envelope provided

- **The 2 aspects of the effort are independent, but linked**
  - Themes and Objectives maturation proceeding with international participation
  - Architecture activity is using incremental inputs from the Objective synthesis activity to develop a point-of-departure, “open” Lunar Architecture

- **Both are also tied to present to the larger community in December of this year**
  - The Themes and Objectives should be of sufficient maturity to form the basis of Architecture definition for any entity interested in the Moon
  - The Architecture output is only the first iteration to serve as the basis for discussion with the larger (International and Commercial and Scientific) community to leverage like interests and Objectives
  - This effort represents the U.S. Architecture in support of the larger global strategy

Exploration Strategy Process

- **Information Gathering**
  - April 2006 Exploration Strategy Workshop
  - NASA's Exploration Strategy Request for Information (RFI)
  - Participating Agency Inputs
  - Studies (encouraged to share material generated in the past)
- **Strategy Development and Refinement**
  - Accurately capture and integrate the inputs received into an initial product
  - Seek involvement from participating Agencies through meetings and conferences (US and International)
  - Interim products developed at regular intervals
  - Opportunity provided for review by stakeholders community
  - Participating agencies can use these opportunities to internally review the draft strategy within their agency
- **Final Product**
  - The final product will be an Integrated Global Lunar Exploration Strategy describing:
    - Themes; Major focal areas of lunar exploration
    - Objectives; Specific achievable task areas that support defined themes
    - Strategy; Time phased strategy for accomplishing defined objectives with key milestones and decision points

Themes and Objectives

- **NASA recognizes that this collection of Themes and Objectives should be comprehensive**
  - NASA may not address all of the Objectives under a given Theme
  - Different agencies and entities will place different priorities on different Themes and Objectives
  - NASA will choose which of the global Lunar Objectives it wishes to fund, guided by the Vision for Space Exploration and NASA's Authorization Act of 2005

- **As a result of the synthesis activity thus far, the Themes can be categorized as Core Themes and Crosscutting Themes**
  - Core Themes (3) tie directly to a unique topic of endeavor for the Moon
  - Crosscutting Themes (3) are more general, and cut across all Themes in implementation

Themes

- **Core Themes**
  - Use the Moon to prepare for future human missions to Mars and other destinations
  - Pursue scientific activities to address fundamental questions about the solar system, the universe, and our place in them
  - Extend sustained human presence to the Moon to enable eventual settlement

- **Crosscutting Themes**
  - Expand Earth's economic sphere to encompass the Moon, and pursue Lunar activities with direct benefits to life on Earth
  - Strengthen existing and create new global partnerships
  - Engage, inspire, and educate the public

- **NOTE**: **These are Global Lunar Themes and Objectives, not necessarily NASA's Lunar Themes and Objectives. NASA is determining which Themes and Objectives within this larger list are appropriate for its missions.**

Lunar Architecture

Lunar Architecture Definition Overview

- Lunar Architecture Definition Study Objective
  - Define the series of lunar missions constituting the Lunar Campaign to fulfill the Lunar Exploration elements of the Vision for Space Exploration (VSE).
    - These missions will include multiple human and robotic missions.
  - Develop the process that will be used for future Architecture updates

- Two Phase Process
  - Phase I - Provide sufficient definition and supporting rationale for near term missions to enable commitment to these missions
    - Define reference missions and campaigns through 2025
    - Concentrate on near term activity to finalize early robotic program (but will include later activity also)
    - Driving to support “rollout” of “NASA architectural thinking” by December 2006
    - Basis for discussions/collaborations/negotiations with International Partners
  - Phase II
    - Iterate the baselined lunar DRM set based on the outcomes of the ESMD Synthesis Team activity
    - Discuss/Collaborate/Negotiate with International Partners
    - Provide greater definition of missions in the 2015 to 2025 time frame
    - Maintain configuration control of appropriate Level I requirements.

Setting the Scientific Context for Exploration of the Moon

- **It is essential that NASA adopt the very strongest science program possible for the Moon right from the outset because advocated weak science would be questioned and could jeopardize the entire lunar program.**
- **Potential science opportunities enabled by human exploration activities must compete in the same prioritization process as the rest of the SMD science program, since the funds come from the same pool.**
- **Science goals are needed to inform early decisions about system design and operations plans for human exploration of the moon.**